Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

SEPTEMBER, 1916.

ASSISTING NATURE TO WORK FOR US.

By THE REV. EDWARD SEELEY.

THIS is really the true description of many kinds of work which we often consider as simply our own, because the active working forces in nature are commonly almost overlooked. Yet without them our work would often be fruitless. This is especially true of the cultivation of the soil.

The wheat plant has a natural faculty that enables it to " tiller " ; that is, to produce additional stems and ears above ground (see Figure 148), and also of surface roots below (see Figure 150), which grow from the joints of the stems at, or very near, the surface of the ground. During the early growth of the plant, if the surface of the soil be raised in contact with the plant, by design or otherwise, an additional growth usually takes place. This may be done repeatedly at intervals, and so a large structure of root-stems may be constructed with a large quantity of what grew at first as surface roots, but were more and more buried as the tillering process continued. This gives man his opportunity of " assisting Nature " and of simultaneously accepting Nature's assistance in producing a larger crop. For by hand cultivation, with a good deal of attention, thirty or more stems and ears may be obtained, as a rule, from each grain sown separately at a distance of eight inches or more from each other, especially if sown in September.

In England, perhaps, it cannot pay if done by man-power only. It must be carried out more quickly on a larger scale ; that is, by machinery and horse-power, or steam, or oil.

But these powers do not effect tillering directly.

The new machine, the tillerer (see Figure 146), consists of a well-known drill, slightly altered, with the addition of the tillerer implements, which consist of a set of moulders (small ploughshares), placed in front of the seeding coulters, to make furrows about four inches deep, below which the coulters sow the seeds. When the seedlings have three small blades the coulters and moulders are removed, and the first set of forks is put into position, and the tillerer is drawn along the lines, with the forks pressing sufficiently on the ridges to restore about half the soil in them to the furrows, nearly burying the little plants. When those plants have again grown three or four blades the second set of forks is put in, and is used to restore the rest of the soil, thus filling up the furrows. In early spring the moulders, without the coulters, can be used to make slight furrows, about two inches deep, where the ridges were, throwing the raised soil over the root of the plants on each side, and so earthing them up and making slight ridges where the furrows were at first. This refreshes the soil, and may destroy many weeds just beginning their growth.

These operations, by raising the level of the soil, assist the natural faculty by inducing fresh rooting and fresh stems.

The manifestation this year at Ashurst (see Figure 147) of the natural power inherent in wheat that is usable by man, is more encouraging than startling, because the past winter was unfavourable for experiment. War conditions delayed the sowing ; and not long after the sowing, winter wet set in, and damp soil for five months kept horses off the ground in the judgment of the farmer. Therefore the normal tillering process was not used as intended, but only the very simplest method of it.

In contrast to the " normal method " above described, the " simplest method " that was actually

used in the case under consideration was indeed simple. It consisted merely of the special seeding, followed by Nature working alone during five months of wet weather, bringing down the soil of the ridges into the furrows; and then, amid the confusion of a great recruiting campaign, a solitary harrowing to refresh the crusted soil.

It should be noted that the broadcast crop on the control plot that was seeded three bushels to the acre shared in the benefits of the harrowing.

The test plot, sown by tillerer, received only one bushel to the acre, and the birds took some of that.

The evident success of that plot already (early in July) seems to mean much more than the success of that simplest method, as it is also good promise of the still greater success in various degrees of the eight or nine other methods of using the tillering process that may be used at discretion according to the needs and possibilities of each case, so that the success of tillerer-sown crops of wheat is now fairly assured in a much greater variety of conditions and circumstances than hitherto had appeared to be probable.

If those who use the process would remember that they are not only using a process and a machine, but also an invisible living power of very great, though almost unknown, effectiveness, they might be able to use all the three more judiciously, and so with greater effect as experience increases, and they approach more nearly to the maximum crop that their land can produce.

The increase of produce by tillerer-sown wheat is generally in three classes, and in each class according to the method used:—

1. Increase in number of ears (see Figure 148).
2. Increase in average length of ears, among ears of all sizes, in the plot compared with those in the control plot (see Figure 149).
   (*a*) Spring-sown wheat and incomplete treatment—about half an inch.
   (*b*) Autumn-sown and the simplest method —about three-eighths of an inch.
3. Stronger rooting, preventing the plants lying down in bad weather.

The writer, who is also inventor of the tillerer, will be glad to co-operate with others in testing the benefits that are practically obtainable through "assisting Nature to work for us."

CORRESPONDENCE.

THE ORIGIN OF COAL: A SUGGESTION.

To the Editors of "KNOWLEDGE."

SIRS,—I was very much interested in the article by Mr. G.W. Bulman, entitled "The Origin of Coal: A Suggestion," which appeared in the July number of "KNOWLEDGE." While I quite agree with him in believing that Professor Shaler's estimate of the rate of coal formation is far too slow, I see no need "to be forced to the conclusion that" a layer of coal is the result of "a one-season's growth."

Mr. Bulman states: "Granting it [the growth] all the rapidity we reasonably can, it is astounding to an orthodox geologist... to be thus forced to the conclusion that anything from an inch to three feet of coal may be formed from one season's growth!" This I fully endorse, but why be forced to this conclusion? We may well believe that some years were more favourable to plant growth than others, and that floods would vary in magnitude and in the amount of mud which they would deposit; but surely it is too much to expect that the vegetation would vary from one year to the next *to such an extent* that the coal resulting therefrom would vary from one foot eight and a half inches to two inches (as given in the data), which would obviously mean that there were over ten times more growth in one year than in the next, under quite similar conditions, except a climate "varying slightly from year to year." Surely a *slight* variation in climate would not produce such a vast difference.

I would suggest that, while the thinner layers of coal *may* be the result of one year's (season's) growth, the thicker ones are the result of *more* than one year's growth.

We assume that the floods varied sufficiently to account for the difference in amount of deposited mud. Why should they not occur at all in some years? Many of our rivers overflow their banks during the wet season, but they do *not* do so *every* year. If one year's vegetation were left unburied, surely we have reason to expect that the vegetation the following year would be more luxuriant and abundant than if fresh plants had to germinate and rise on bare ground. This we should expect at the present time, and why not in Carboniferous times?

Mr. Bulman speaks of one inch to three feet of coal being formed from a single generation of plants, and "every such layer must be a one-season's growth." While a layer of coal would probably be produced by a single generation of plants, this is not to say that it must be a *one-season's* growth, for we have no reason to suppose that the Carboniferous plants were annuals; on the contrary, they seem to have been perennials as their surviving descendants (*e.g.*, Lycopodium). A second or third year's perennial plant growth may be expected to yield an increased quantity of spores and vegetable coal-forming matter over that of the first year.

Thus, according to my suggestion, the burying is done at the same rate, but not as often as that of which Mr. Bulman speaks, but that in some cases (at least) more than one year's growth was buried to form the layer or seam. This hypothesis also (as does the single-season one) removes the difficulties of the rate of decay, and we have again no need to suppose that a fresh generation sprang up on a bed of leaves; it also accounts for the "partings" and the varying thicknesses of the layers and seams.

C. STEVENSON GARNETT.

CROSS STREET,
CHESTERFIELD.

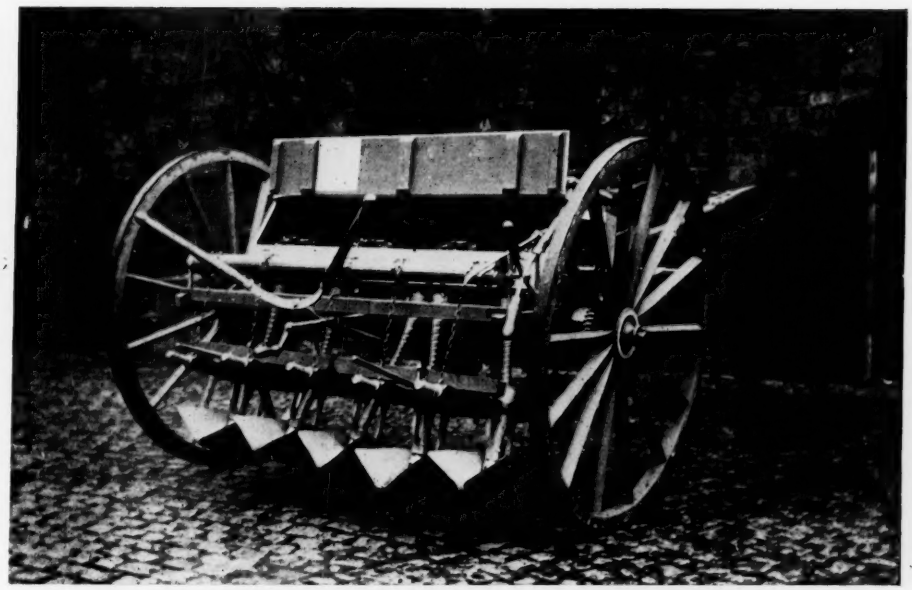

FIGURE 146. Machine for tillering wheat, invented by the Rev. E. Seeley.

FIGURE 147. A plot of tillerer-sown wheat at Ashurst, May 22nd, 1916.

FIGURE 148. Increase in the number of ears. Two plants from the tillered plot are shown on each side from one of the control plot.

FIGURE 149. The increase in the length of the ear. The left-hand specimen is from the tillered plot, the right from the control.

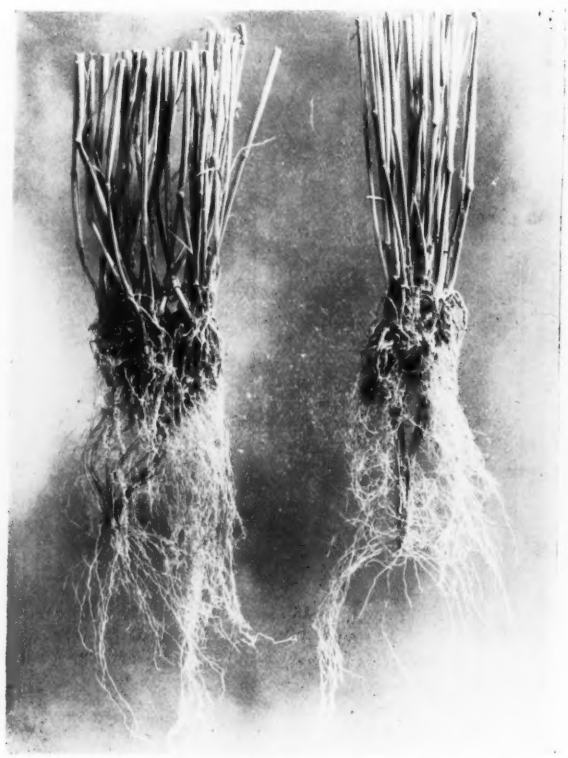

FIGURE 150. The roots of two wheat plants specially tillered by hand.

FOSSIL OTOLITHS.

By COLONEL C. E. SHEPHERD (Indian Army).

Fossil otoliths are found in many places and, in some, in great numbers. It is interesting to speculate from whence they came; how it is that many are congregated in certain spots; what use they are in helping modern men of science to realise the distribution of fishes at an anciently remote date; to compare also what fishes were common to British and foreign waters; to ascertain what fishes have become extinct in various localities; and for geologists to recognise what families of fishes were prevalent at the time when different formations and strata were being laid down in the building up of the world as we now know it. These otoliths—concretions of limestone—have existed through many ages, and have kept throughout that time indications on their surfaces that enable anyone who studies them to say for certain, in the case of those where these indications are still fairly clear, to what family of fishes the original possessors of the otoliths belonged. A. S. Jensen, in writing of recent fish otoliths found on the bottom deposits of the sea, mentions otoliths of the Gadus (cod) family being found in North Polar waters,* and says that " many specimens of *Gadus poutassou* otoliths are dredged up from the bottom of the Polar Sea, between Iceland and Jan Meyer Island, in depths between one hundred and two to one hundred and twenty fathoms (the Danish fathom equals *circa* 6·2 feet), with occasionally others, *G. callarias, G. saida, G. virens.*" These are all present-day Gadidae. He puts it down to fish dying in cold water that had been living in warmer water, and to the excreta of fish-eating whales. As a proof of the devastation caused to fishes by a sudden change in the warmth of the water, he adduces the excessive mortality noted amongst the *Lopholatilus chamaeleonticeps* (the Tile fish) in 1882, when millions of these fish were killed, supposedly, by a sudden change in the temperature of the water. Their dead bodies covered the sea for hundreds of square miles. But this would not account for the hundreds of thousands, possibly millions, of fishes that must have died within such limited areas as the Barton Clay beds, or the strata at Monte Gibio, in Italy, where fossil otoliths of many families and species are found mixed up and in great numbers. In the case of the Tile fish, the dead bodies floated and were dispersed by wind and waves over a very extensive area. That the fish-eating cetaceans would form a prolific source of otoliths being found on the bottom of the sea we have direct confirmatory evidence. In the Twenty-first Annual Report of the Fishery Board for Scotland, Part III, page 126, it states that the stomach of a common porpoise contained no fewer than two hundred and eighty otoliths, two hundred and forty of which were recognised as almost certainly of whiting, twelve appeared to belong to some other Gadoid, and the others were extremely small, and somewhat resembled the ear-stones of sand-eels. To cetaceans, as a source of supply, sharks and other fish-eating fishes might be added.

Fossil otoliths are known from many localities. In England, in the neighbourhood of London, they have been found in the London Clay (Eocene) at Finchley, Highgate, and Chalk Farm, from whence specimens allied to the Gadidae and Sparidae have been procured. They have been found in the following counties, namely :—

Buckinghamshire ...	Kimeridge Clay ...	Upper Jurassic
Cornwall	— ...	—
Essex	— ...	—
Hampshire	Barton Clay ...	Upper Eocene
Isle of Wight ...	— ...	Oligocene
Kent	Gault ...	Cretaceous
Middlesex	London Clay ...	Eocene
Norfolk	Red and Coralline Crags.	Pliocene
Northamptonshire...	Upper Lias ...	Lower Jurassic
Oxfordshire... ...	Kimeridge Clay ...	Upper Jurassic
Somersetshire ...	Middle Lias ...	Lower Jurassic
Suffolk	Red and Coralline Crags.	Pliocene

From these localities representatives of many fish families are to be found, namely, Sparidae, Siluridae, Gadidae, Serranidae, Pleuronectidae, and others; sometimes sparsely, as in the Red and Coralline Crags; sometimes abundantly, as in the Barton Clay.

In France, by reference to articles published by Professor F. Priem, they have been found in the following departments: Manche, Oise, Seine-et-Oise, Loire-Inférieure, Gironde, Basses-Pyrénées (in this latter they are found in Eocene), and in the Alpes-Maritimes, where they are found in Pliocene deposits. These departments cover portions of the north, west, and south of France. They are also found in Corsica in Pliocene strata.

In Italy they are known by a paper published by Professor G. G. Bassoli, from the provinces of Tuscany and Aemilia, from Miocene and Pliocene strata. From Monte Gibio, near Modena, out of Pliocene strata he records having examined about ten thousand three hundred otoliths, the most numerous family being that of the Berycidae (? Scopelidae, see *post*), represented by thousands in those examined, other families being Macruridae, Gadidae, Sparidae, Ophidiidae, Hoplostethiidae, and so on. Otoliths are also known from Miocene

* *Middelelser fra Kommissionen for Havander, segelser Serie Fiskeri*, Bind I, No. 7.

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strata in Piedmont, from the neighbourhood of Turin and Tortona. Dr. Eugenio Sismonda figures the otoliths found,* but gives no names. His figures are, however, so clear that the families can be fixed as Siluridae, Hoplostethiidae, and Gadidae. In Sardinia, otoliths have been obtained near Cagliari from Miocene strata.

In Germany, Professor E. Koken quotes many places besides Holstein and Hanover, where, in Miocene and Oligocene strata, otoliths of Gadidae, Macruridae, Berycidae, Hoplostethiidae, Ophidiidae, Sciaenidae, one he calls *Incertae sedis umbonatus*, and other fish are found.

In Denmark, Koken also notes that otoliths of many of the above-named families have been found in Eocene strata near Copenhagen. Professor M. Leriche quotes a Siluroid otolith (*Arius Danicus*) from the same strata and locality.

In Austria and Hungary, from Tertiary strata, Professor R. J. Schubert, in a series of papers, has notified that from the Miocene and Pliocene deposits in Moravia, East Bohemia, and Hungary he has obtained *Sciaena*, *Macrurus*, *Hoplostethus*, and *Beryx* family otoliths.

From Bosnia, from Tertiary strata, Professor Schubert has recognised otoliths of the Berycidae. (? This allocation might require modification. See *post.*)

In Belgium, otoliths from the Eocene are quoted in Professor Leriche's memoranda as belonging to the *Hoplostethus* and *Arius* families.

From Roumania there is one specimen of the otolith in the British Museum Natural History, Geological Department.

In Russia, from the island of Tchelken, Eastern Caspian, otoliths belonging to Sciaenoid families have been found.

In Burma, fossil otoliths have been found in Miocene strata from the neighbourhood of Yenangydung, where the oilfields are.

In the United States of America they are found, Professor E. Koken says, in the Upper Tertiaries of the States of Mississippi and Alabama, otoliths of Sciaenidae, Sparidae, *Incertae sedis umbonatus*, and other fishes having been recognised.

The presence of Siluroid otoliths, and of more than one species and in great numbers, in the Barton Clay, Hampshire, is interesting from the fact that this class of fish is extinct in the British Isles. The nearest Siluroid relative at the present time is to be found only east of the Rhine, the *Silurus glanis*, called "Wels" in Germany.† Siluridae are plentiful in tropical waters (fresh and salt); they are also found in the lakes of Canada. It is only from the Siluridae that the Lapillus is found in the fossil state. In this family it is the largest of the three otoliths found in each side of the cranium, and is in marine Siluridae a comparatively large and solid stone, especially in the *Arius* family and its allies. In all other cases it is always the Sagitta that is found in the fossil state. The absence of Sciaenoid otoliths in England, although they are plentiful in Germany, Austria, and Italy, is notable. These fish at the present time are rare on the British coast. None can be said to frequent it. *Sciaenaquila* (the "Meagre") is the only one occasionally caught.

Seemingly plentiful in species, by the otoliths found in the Austrian Tertiaries and in German strata, there are now only three representatives of the family in the present-day Mediterranean. In tropical waters they are numerous. The otolith mentioned above, called *Incertae sedis umbonatus*, is so far interesting that in its outer face markings it is quite different from the otoliths of the present day [see Figure 155 (8)]. The mouldings all seem to grow out of the upper edge and extend towards the lower. In recent otoliths, and in the fossil Sparidae and Siluridae, the mouldings radiate from a central "umbo" [see Figure 155 (1) and (5)]. The Gadidae do not show this grouping round a central core; the Pleuronectidae do. An explanation of the terms used in discussing otoliths would seem necessary to elucidate the above and following remarks. Otoliths,‡ normally three on each side of the head, are found only in Teleostean fishes, and are called the Lapillus, the Asteriscus, and the Sagitta. The first and last of these have been alluded to before. No fossil Asteriscus, so far as it is known, has been reported as having been found. It is the largest of the otoliths in the Cyprinidae and Characinidae, and might be found in freshwater deposits. It is, however, of frailer make than a Sagitta, or the Siluroid Lapillus, consequently would be more easily reduced to fragments. A diagram is given of an otolith with the terms applied to it (see Figure 151).

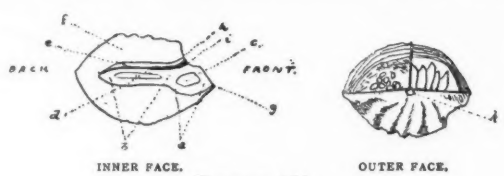

FIGURE 151.

Diagram of Otolith.

a Ostium. *b* Cauda.
c Front; and *d* Back colliculum.
e Crista superior. *f* Area.
g Rostrum. *h* Antirostrum.
i Excisura ostii. *k* Umbo.

The otolith in the head stands on its edge, but inclined from the vertical, so that the faces are turned one outwardly (this face is generally concave), the other inwardly (this face is always con-

* *Mem. Accad. Scienze di Torino*, 1849, Bd. X, Tav. II, Figures 60–71.

† *Amiurus nebulosus*, another Siluroid now to be found in Continental waters, is outside the scope of this article, having been introduced from America in quite modern times.

‡ Only those of fishes are alluded to and described in this article.

vex). The inner face rests against the *macula acustica* of the containing sacculus, and at the corresponding spot on the inner face of the otolith one sees a furrow running from the front edge towards the back edge. This is the *sulcus acusticus*. The sulcus consists of two prominent portions: an anteriorly enlarged space, (*a*) the *ostium*; and a more narrow portion proceeding out of it, (*b*), the *cauda*, which has often a more or less pronounced downward curve at its extremity. In the sulcus and cauda projecting portions are sometimes found rising up in the bed of the furrow. They are called (*c*) *colliculum anteriore* and (*d*) *colliculum posteriore*. The upper edge of the furrow, always the more strongly defined, is known as (*e*) the *crista superior*. Beyond the two edges of the sulcus there is a depressed part sloping away from the sulcus: this is known as (*f*) the *area*. The ostium is bounded anteriorly by two ridges, the lower, (*g*) the *rostrum*, being more prominent; then (*h*) the *antirostrum*. Below the antirostrum there is a marked indentation, (*i*) the *excisura ostii*. The otolith standing on its edge, the upper or dorsal, the lower or ventral, the anterior or cranial, and the posterior or caudal edges explain themselves. The outer concave face may show concentric striatures or radiating ones, more or less clearly defined, starting from a central projecting point, (*k*) the *umbo*, as in the lower half of the diagram; or the outer face may have granulations, often very pronounced, or ridges running across the face (see the upper half of the diagram). One or both of these two forms of marking are usually seen in Sciaenoid otoliths. Or there may be mouldings and sculpturings over the face not emanating from a central umbo, as seen in the otoliths of the Gadidae in especial. On the outer face is often seen in Sciaenoid otoliths, near the edges, a number of concentric lines. Similar lines are also visible in some Siluroid fossil otoliths [see the upper two in Figure 155 (5), which shows them]. These are traces of the lines of growth of the otolith. This stone, although nearly wholly carbonate of lime (ninety-three to ninety-five per cent.), also contains phosphate of lime, and, when recent, traces of organic matter. To the decomposition of this latter is probably due the extra clearness with which these lines show out in the fossil state. The above diagram and the names of the different parts of the same have been taken from Professor E. Koken's description published in his paper of 1884. The diagram of the outer face has been modified to show three different kinds of sculpturing. The above diagram, whilst a generalisation for many groups of fishes, such as Sciaenidae, Sparidae, Serranidae, and so on, is not so clear for the Gadidae, where the sulcus does not show its more important two parts so definitely, the ostium being a broader opening than, and running in a line with, the cauda, the two sometimes crossing the stone longitudinally from end to end, the colliculi also being more clearly defined. Neither does the diagram suit the Pleuronectidae, nor the Gobiidae, each with a sulcus not showing a defined ostium and cauda.

The sulcus acusticus is an important, if not the most important, feature in determining the family to which a fish belonged. It keeps to its general form, but the extent of the ostium, the width of the cauda, and the amount of curvature given to the extremity thereof are subject to variation. The Figure 155 (1) (the second one from the top), marked *a*, is a typical Sparoid sulcus, with a decided curvature at the extremity. The fourth and sixth, marked *b*, examples also show the same type, but the cauda does not terminate in such a decided curve. Amongst recent fishes, *Pagellus centrodontus* (the "sea bream") gives an example of the decided curvature; whilst *Sargus Rondolettii* (a Mediterranean Sparoid fish) is an example of that with a less curvature. Figure 155 (2) (the second one from the top) shows a typical Gadoid sulcus, and the two colliculi are plain. As noted above, it is in the Gadidae that these colliculi are most apparent. The outer face [see Figure 155 (2)] shows the markings and sculpturings which in this family are strongly defined. The Siluridae [see Figure 155(5)] do not show a well-defined sulcus either in the fossil or the recent state. In Figure 155 (7) the middle otolith shows a well-marked sulcus that assimilates to the sulcus of *Psetta maxima* (the "Turbot" amongst living fishes). Figure 155 (8) shows that the sulcus *per se* is not everything in determining the origin of an otolith. It has also to be taken in conjunction with the general contour and the markings of the outer face. Three of the otoliths shown under this number display a well-defined sulcus, but taken in conjunction with the markings of the outer face no recent family of fishes gives a clue as to which the possessor of these stones should be ascribed. The sulcus acusticus of the Sciaenidae is very distinctive. It is shown in Figure 157 (7). As the figure, taken from a photograph, owing to the shadow is not as clear as could be wished, a sketch of the sulcus of *Sciaena aquila* (the "Meagre") (half natural size) is also given in Figure 152.

FIGURE 152.
Sciaena aquila.

FIGURE 153.
Beryx splendens.

(Half natural size.)

A comparison—they are in each instance from the left side of the head—will enable the shape to be followed out in the photograph. The broad ostium, covering a large part of the anterior portion of the inner face, the bold and lengthy downward curve of the cauda, are unmistakable. In the specimen photographed, unfortunately, a portion of the anterior edge of the above is wanting, so that the full ostium does not show. This portion often breaks off in Sciaenoid fossil otoliths. It is due to the slight upward tilt that the outer concave face

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has at this point. In the plate illustrating Professor Schubert's paper on the fossil otoliths of the Sciaenidae from the Austro-Hungarian Tertiaries, published in 1901, quite one-half of the illustrated fossil otoliths figured shows the same damage as having occurred to them. Owing to colour-staining from lying in the soil, the sulci of fossil otoliths show far more clearly than those of living fishes. They come out more vividly on being photographed, as may be seen in Figures 154, 155, and 156. In many photographs of the otoliths of recent fishes that have lately been taken the sulcus does not show at all.

Attempts have been made to get at the otoliths in the heads of Berycidae from the chalk. In the living Berycidae the Sagitta is a fairly solid stone (see *post*). Although the chalk was carefully scraped away in the locality where the otolith should have lain, no trace of the stone could be found. Being nearly of the same composition chemically, whether in the lapse of ages it had become absorbed into the chalk, or how it disappeared, cannot, of course, be more than surmised. Two other attempts were also made upon heads of Cyprinidae, a *Lenciscus*, and a *Tinca* from Carboniferous strata in Germany, but the specimens were too hard; only the smallest fragments were got off. There seems no hope that otoliths can be got from such specimens. The only other means, and the source of the present supply, is by washing or sifting the clay or sand in which the fossils are lying. From the Gault, however, the fossils can be cleared by careful scraping. One case where a fossil otolith was obtained direct from a fossil skull deserves to be mentioned. It was got by Mr. E. T. Newton, F.R.S., from a Siluroid skull found in the Barton Clay. It was described and figured by him in *The Proceedings Zoölogical Society*, London, 1889, Plate XXI, page 201. The hole from which the fossil Lapillus was extracted is shown in the illustration corresponding exactly with the position occupied by the Lapillus in any recent Siluroid fish. This specimen and the fossil Lapillus therefrom are now in the Museum of Practical Geology, Jermyn Street, London.

When attention began to be paid to fossil otoliths, and they commenced to be collected, it became necessary to give them names to distinguish them and for purposes of reference, more especially those that resembled each other, but which, again, had slight differences. Continental palaeontologists do this steadily, but are perhaps a little too prone to make new species on very slight evidence. Professor E. Koken seems to have been the pioneer in attaching distinctive appellations to fossil otoliths. He started a system of calling them all *Otolithus* to begin with. He then added a family name connecting them with living fishes, which name he put in brackets, and added a specific name, e.g., *Otolithus* (*Gadidarum*) *elegans*. When he was unable to satisfy himself as to the family, he cautiously called them *Otolithus* (*Incertae sedis*), adding *umbonatus* or some other specific name. When a fossil otolith very closely resembled that belonging to an existing fish he adopted the plan of adding *pre-* to the specific name of the living fish as the specific name of fossil otolith. Thus we get *Otolithus* (*Merluccius*) *pre-esculentus*. The prefix *Otolithus* shows that a fossil otolith is under discussion; living species are alluded to without it. Professors F. Priem (France), G. G. Bassoli (Italy), and R. J. Schubert (Austria), who have contributed largely to the literature of fossil otoliths, have adopted the same plan. It is a practical one, and is adopted in this paper further on where fossil otoliths, as yet unrecognised and unpublished, require to be set up with a name. Every effort should be made not to apply a different name to a stone already described and illustrated, but to retain the prior nomenclature if the family name in especial is correct. If desirable to fix the locality from which derived the addition of "var" with the locality added will satisfy this requirement, whilst respecting the prior nomenclature. As an instance, Figure 156 (1) shows a stone very similar to the one figured by Professor Leriche.* He quotes it as *Ot.* (*Arius*) *Danicus*, adopting a name suggested by Koken at the end of the latter's description of *Ot.* (*Arius*) *Vagionis* as a *nov. nom.* for the same stone. If, then, the stone is called *Ot.* (*Arius*) *Danicus* var *Bartonensis*, the prior nomenclature by Koken and Leriche would be respected, and the locality from which this particular stone came would be identified, adding to the interest by showing the distribution of any one particular fish. In this instance *Arius Danicus* is known from Denmark, Belgium, and England. The disadvantage, if any, of the proposed system is that the name becomes rather lengthy; but the advantage of not duplicating or triplicating names for one and apparently the same specimen, and the respecting the priority of an already given name, is not to be denied.

Fossil otoliths of the Upper Eocene, from the Barton Clay, Hampshire, are shown in Figures 154, 155, and 156.† Those under Figure 155 show the inner and outer faces of otoliths belonging to the Sparidae. The resemblance of that marked *a* to *Pagellus centrodontus*, and *b* to *Sargus Rondolettii*, has been noted above. These names, then, are proposed to be retained with the prefix *pre-* to the specific name. Figure 155 (2) are undoubtedly Gadoid, and seem all similar. *Gadus virens* of the present day is the one they most nearly resemble in marking and shape. They are consequently allied to them by

* *Mém. Musée Roy. d'Hist. Nat. de Belgique*, 1902, Tome II, page 25.

† All the Barton Clay otoliths shown are from specimens collected and presented by Mr. H. Eliot Walton. I here express my thanks to him.—C. E. S.

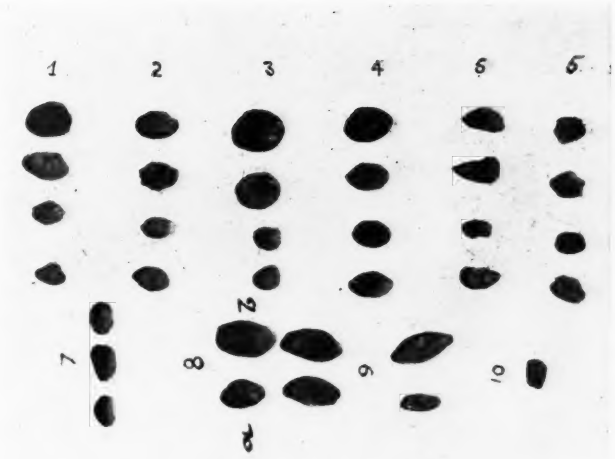

FIGURE 154.

Upper Eocene. Barton Clay, Hampshire, England. (1) *Otolithus* (*Monocentris ?*) *bellvicianus*. (2) *Ot.* (*Monocentris ?*) *Leridei*. (3) *Ot.* (*Apogonidarum*) *circularis*. (4) *Ot.* (*Apogonidarum*) *Eocenicus*. (5) *Ot.* (*Gadidarum*) *Waltoni*. (6) *Ot.* (*Apogonidarum*) *nota*. (7) *Ot.* (*Gadidarum*) *elevatus* Kok. (8) *Ot.* (*Serranidarum*) *Bartonensis* and *Ot.* (*Serranidarum*) *concavus*. (9) *Ot.* (*Trachinus*) *verus*. (10) *Ot.* (*Phycis*) *tenuis* Kok.

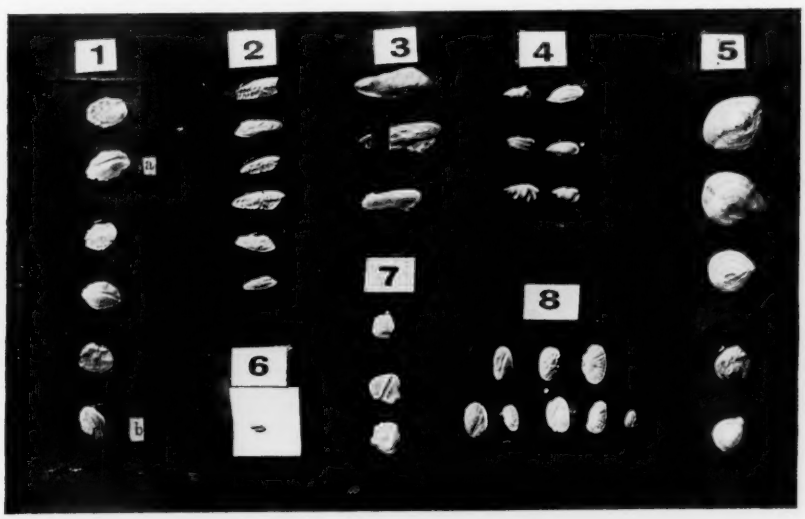

FIGURE 155.

Upper Eocene. Barton Clay, Hampshire, England. (1) *Otolithus* (*Pagellus*) *precentrodontus* and *Ot.* (*Sargus*) *pre-Rondolettii*. (2) *Ot.* (*Gadidarum*) *previrens* (young specimens). (3) *Ot.* (*Gadidarum*) *pseudo-aeglifinus*. (4) *Ot.* (*Gadidarum*) *preminutus*. (5) *Ot.* (*Arius*) *crassus* Kok. var *Bartonensis*. (6) *Ot.* (*Clupea*) *testis* Kok. (7) *Ot.* (*Psetta*) *premaxima*. (8) *Ot.* (*Incertae sedis*) *umbonatus* Kok.

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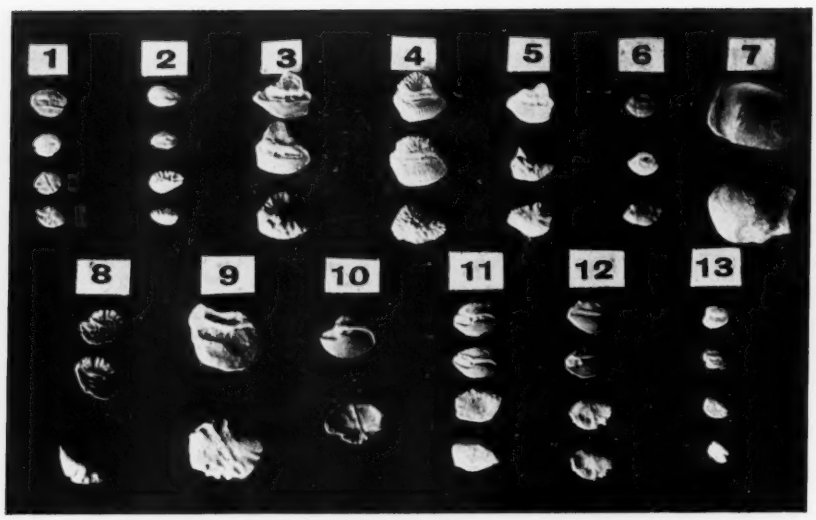

FIGURE 156.

Pliocene. Monte Gibio, near Modena, Italy. (1a) *Otolithus* (*Berycidarum? Scopelus*) *sulcatus* and (1b) *tuberculatus*. (2) *Ot.* (*Macrurus*) *Toulai*. (3) *Ot.* (*Macrurus*) *Arthaberi*. (4) *Ot.* (*Macrurus*) *gracilis*. (5) *Ot.* (*Macrurus*) *ornatus*. (6) *Ot.* (*Ophidium*) *Pantanellii*. (7) *Ot.* (*Sciaena*) *speciosus*. (8) *Ot.* (*Hoplostethus*) *premediterraneus*. (9) *Ot.* (*Hoplostethus*) *orbicularis*. (10) *Ot.* (*Percidarum*) *arcuatus*. (11) *Ot.* (*Sparidarum*) *mutinensis*. (12) *Ot.* (*Deutex*) *speronatus*. (13) *Ot.* (*Gobius*) *aff. vicinalis*.

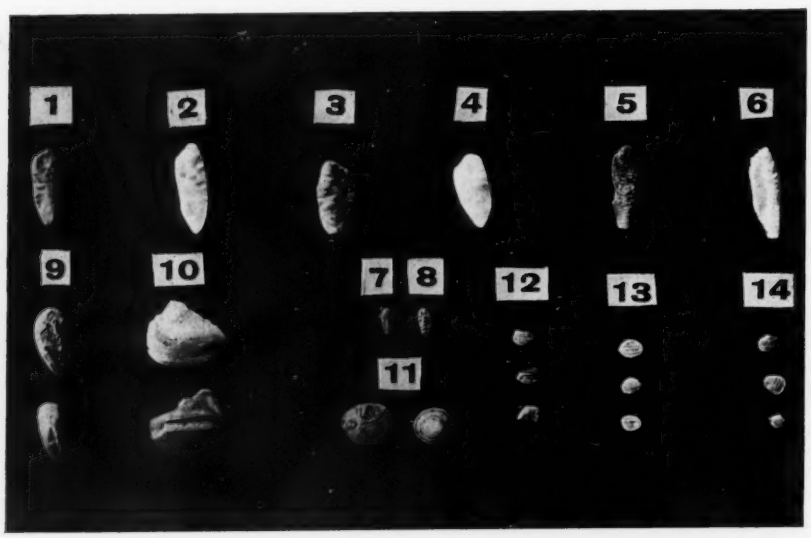

FIGURE 157.

Pliocene, Cretaceous, and Upper Eocene. England. (1) *Otolithus* (*Gadidarum*) *pseudo-aeglifinus*. (2) *Gadus aeglifinus*. (3) *Ot.* (*Gadidarum*) *Anglicus* var *corallinensis*. (4) *Gadus luscus*. (5) *Ot.* (*Gadidarum*) *premerlangus*. (6) *Gadus merlangus*. (7) *Ot.* (*Phycis*) *elegans* var. *sculpta*. (8) *Raniceps raninus*. (9) *Ot.* (*Gadidarum*) *Gaultina*. (10) *Ot.* (*Atherina*) *Cantiana*. (11) *Ot.* (*Arius*) *Danicus* var. *Bartonensis*. (12) *Ot.* (*Gadidarum*) *mucronatus*. (13) *Ot.* (*Scopelus*) *splendidus*. (14) *Ot.* (*Scopelus*) *biarritzensis* var. *Bartonensis*.

name. Number 3, Figure 155, are unmistakably Gadoid also, assimilating to *G. aeglifinus*. They are named *Ot.* (*Gadidarum*) *pseudo-aeglifinus*, that name being already attached to similarly shaped ones in the British Museum Natural History. Number 4 are likewise Gadoid, and may be referred to *G. minutus* of the present day; consequently they are named after them. Number 5 are incontestably Siluroid in origin. They are Lapilli, and resemble those figured by Koken, and called *Ot.* (*Inc. sed.*) *crassus* in the 1884 paper. He afterwards, in 1891, recognised them as belonging to the Arius family. They are therefore named *Ot.* (*Arius*) *crassus* var *Bartonensis*. The peculiar pointed extremity showing in the second one from the top and the bottom one, and slightly indefinitely in the others, as if water-worn, is reproduced in modern times in the stones of *Arius pro-ops* and others of the family. The fossil otoliths under Number 5 may safely be taken as representing a Siluroid akin to the Arius family, as other fish remains, spines, and so on, found in the Barton Clay resemble that of the said family. Another Siluroid otolith shown in Figure 156 (11) is found in the Barton Clay, but in nothing like such numbers as in Figure 155 (5): these have been found in hundreds. But two specimens of Number 6 were found in over two thousand otoliths examined and carefully looked through. It resembles *Ot.* (*Clupea*) *testis*, described by Koken, and also illustrated in his 1891 paper, Taf. I, 1a. This name is retained. Number 7, by its sulcus and shape, seems to be derived from some Pleuronectid fish, to which *Psetta maxima* (the Turbot) is the present-day representative; hence its designation as *Ot.* (*Psetta*) *premaxima*. Number 8 has as yet had no satisfactory present-day representative found for it. The sculpturing is so very marked, in specimens that are well preserved, that were any known they could not fail to be identified. The sulci also in the top left-hand and bottom right-hand specimens are well defined. These stones seem similar to that illustrated in Professor E. Koken's paper, 1884, to which he gave the name *Ot.* (*Inc. sed.*) *umbonatus*. He says they have been found in the United States of America, as well as in Germany and Denmark. *Umbonatus* shows marks of sculpturing on its inner face. Sculpturing on the inner faces of fossil and recent otoliths is not common, but it does occur in fossil otoliths, as will be seen later on.

Figure 154 shows more of the fossil otoliths from the Barton Clay. These are generally so small that they have been enlarged to one and two-thirds their natural size to bring out their characteristics. Numbers 1 and 2 resemble some otoliths already called *Ot.* (*Monocentris*) *bellivicianus* and *Ot.* (*Monocentris*) *Leridei*. The differences in the sulci is very little between the two figures, the latter having a slightly more contracted ostium. Monocentris is a rare fish in the present day.* Number 3: The name suggested is *Ot.* (*Apogonidarum*) *circularis*. Professor Priem, in his 1906 paper, shows one which he has named *Ot.* (*Apogonidarum*) *orbicularis*. It is of similar shape to Number 3; his sulcus differs. There is also a trace of a depression in the upper part of the area of Number 3 which does not show in Priem's figure. Number 4 shows this depression distinctly of an elliptical shape. This depression is a characteristic of the otoliths of *Apogon bifasciatus* from the Indian Ocean. It is also seen in *Apogon rex-mullorum* from the Mediterranean, due to this depression and the general shape of the sulci. Numbers 3 and 4 have been allocated to the Apogonidae. The name *Ot.* (*Apogonidarum*) *Eocenicus* is proposed for Number 4. Günther† says of the Apogonidae nearly one hundred species have been described, of "which a few only occur in the Atlantic, one extending northward into the Mediterranean." In the volume of Cambridge Natural History Series on "Fishes, Ascidians, etc.," Apogon is classified as a sub-family of the Serranidae, and the statement is made:‡ "*Morone*, *Serranus*, *Percichthys*, *Anthias*, and *Apogon* are represented in Eocene and later strata." Admitting the allocation of Numbers 3 and 4 to the Apogonidae, this family, like the British Siluridae beforementioned, has left British waters for warmer tropical areas. It may be pointed out that Professor Priem in his 1906 publication, on page 272, shows an otolith he names *Ot.* (*Apogonidarum*) *Boulei*, where a slight shadow is depicted that probably marks the site of a similar depression. For Number 5 the name *Ot.* (*Ophidiidarum*) *Waltoni* had been suggested in honour of Mr. H. Eliot Walton, to whose indefatigable labour in collecting these Barton Clay fossil otoliths our knowledge of them is due. The allocation to the Ophidiidae, however, cannot be accepted. The otolith under Number 5 resembles that shown in Koken's 1891 paper, Taf. I, 7 and 7*a*, which he calls *Ot.* (*Ophidiidarum*) *differmis*, but the sulcus of this differs so much from two others which Koken shows in the same paper (Taf. X, 17 and 18) that one hesitates to accept the allocation of Number 5 to the Ophidiidae. The sulcus assimilates more to the kind shown by Koken in his 1884 paper (Taf. XI, 8, 11, and 13), and the contour, outer surface, and sharp-pointed extremity generally to *Ot.* (*Gadidarum*) *mucronatus* (Koken, 1888, Taf. XVIII, 10), that it would be safer to allocate Number 5 to the Gadidae and call it *Ot.* (*Gadidarum*) *Waltoni*. Owing to a slight dent-like depression in the upper part of the area of Number 6, it may be put with the Apogonidae, and the name *Ot.* (*Apogonidarum*) *nota* is proposed

* Since the above was written specimens of this fish have come to hand. The sulcus corresponds with those of the fossil otoliths. The original allocation was made by the late Professor R. J. Schubert. It may be accepted.

† Günther, *Study of Fishes*, 1880 edition, page 395.

‡ *Camb. Nat. Hist.*, "Fishes, Ascidians, etc.," page 660.

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for it. Number 7 resembles that shown by Koken in his 1888 paper (Taf. XVII, 5), which he names *Ot.* (*Gadidarum*) *elevatus*. That name is retained. The otoliths of Number 8 may safely be classed as belonging to the Serranidae. By Günther the Serranidae are placed in the family of the Percidae, and at page 381 of his " Study of Fishes " he writes of them as " sea perches proper." Foreign writers also seem to do the same. The left-hand side otolith under Number 8 (*a*), by it sulcus, resembles closely that shown by Priem (1912 paper, page 248) as *Ot.* (*Percidarum*) *Bartonensis*. It came from the Barton Clay. This name is retained with the correction of calling it *Ot.* (*Serranidarum*) *Bartonensis*, to bring it into the more modern classification of fishes, *Serranus* being recognised as a family of its own. The right-hand side otolith under Number 8 (*b*) differs slightly in the shape of the ostium. It is not quite so rounded below. Priem's 1913 paper (page 152) shows a similar one to Number 8 (*b*) : he calls it *Ot.* (*Percidarum*) *concavus*. This name is retained with the correction *Ot.* (*Serranidarum*) *concavus*. This stone resembles that of *Morone labrax* (the Bass of present-day fishes). Morone and Serranus are represented in Eocene strata (see *ante*). Number 9 may be safely set down to the Trachinidae. It resembles sufficiently closely to *Ot.* (*Trachinus*) *verus*, shown in Koken's 1891 paper (Taf. X, 13 and 14) for that name to be retained. Only these two were found amongst many hundreds of otoliths looked through. Number 10 belongs to the Gadoid family, and resembles *Ot.* (*Phycis*) *tenuis* of Koken's 1891 paper (Taf. IV, 3 and 3*a*). Name retained. Besides the specimens shown in Figures 154 and 155, those belonging to the Barton Clay, shown in Figure 156, must now be reviewed. Number 11, as mentioned above, has proposed for it the name *Ot.* (*Arius*) *Danicus* var *Bartonensis*. It resembles the stone figured by Leriche (1902 paper, page 25). The contour does not show the slight projection that is noticeable in *Ot.* (*Arius*) *Germanicus* of Koken, and may be rightly considered a different species. Figure 156 (12) resembles the otolith shown by Koken (1888 paper, Taf. XVII, 10) as *Ot.* (*Gadidarum*) *mucronatus*. It would seem a question whether these are not identical with those shown under Figure 154 (5), but there seem slight differences between them. The strong resemblance would seem another reason for classing Figure 154 (5) with the Gadidae. Number 13 was received from Italy allocated to the Berycidae, but that allocation, as will be shown later on, cannot be sustained. It was entered in the figure because the sulcus resembled the sulcus of those of Number 14, showing that fishes of a same family were existent in the Eocene of England and the Pliocene of Italy. Number 14, to follow the suggestions of Priem's 1911 paper, should be classed with the Scopelidae (see his figures, page 45 ; also his 1912 paper, page 247). This latter he allocates to *Ot.* (*Scopelus*) *Biarritzensis Bartonicus*, as he received it from a Monsieur E. Boury, who obtained it at Barton. The resemblance to the otolith shown under Number 14 is sufficiently good to accept his name, which is accordingly done. The allocation to the Scopelidae is also correct when compared to *Scopelus punctatus* among living fishes. Fossil genera of Scopelidae are known from Eocene, Oligocene, and Miocene strata (see " Camb. Nat. Hist., Fishes," page 611). Barton Clay is a most prolific source of fossil otoliths. Besides the otoliths above illustrated, others from the same strata have been found that may be attributed to the Macruridae, Gobiidae, Ophidiidae, and Pleuronectidae (Solea).

(*To be continued.*)

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

OBITUARY.—Though Sir W. Ramsay was a chemist, not an astronomer, yet some of his work had such a close relation with our science that a reference to it in this column is appropriate. It will be remembered that the name " helium " was given to the unknown substance that gave rise to some prominent lines in solar and stellar spectra. A quarter of a century after the name had been given, Sir W. Ramsay found the gas on Earth, it being given off by cleveite and some other minerals. This discovery has been of advantage to astronomy, by enabling the properties of the gas and the variations of its spectrum to be studied in the laboratory. He subsequently found that helium is one of the substances given off by radium. In view of the great prominence of the helium lines in the stars of the Orion type, which are intrinsically the brightest of all the stars, it is evidently an element of vast importance in cosmical physics, and it is likely that its relations to the radio-active elements will ultimately throw more light on the development of stars. Sir W. Ramsay is also celebrated as the discoverer of several new constituents of the terrestrial atmosphere—argon, neon, krypton, xenon. Our atmosphere has a cosmical as well as a chemical interest, since to a certain extent it stands as a type and model of all the planetary atmospheres. The spectral lines of some of these rare gases have been detected in the aurora, so that they seem to be peculiarly liable to electrical excitement by the ions ejected by the Sun.

LARGEST TELESCOPE IN THE WORLD (FOR CANADIAN OBSERVATORY).—These extracts from *The Times* of July 19th and 21st, relating to the new great Canadian reflector and the famous Rosse telescope, will probably interest our readers. The mirror of the latter was of speculum metal, which is of inferior reflective power to the silver-on-glass mirrors now employed. The method of mounting the new instrument is incomparably more convenient than that of the Rosse telescope. It should also be remembered that the one-hundred-inch reflector of the Mount Wilson Observatory is rapidly approaching completion, and will probably commence work almost as soon as the Canadian one. There have been two successful sixty-inch reflectors. One was constructed by the late Dr. Common at Ealing, and produced some excellent

photographs of nebulae (after his death it went to America); the other has been in use for some years at Mount Wilson for researches on astrophysics, and occasionally for planetary work.

LARGEST TELESCOPE IN THE WORLD.

FOR CANADIAN OBSERVATORY.

A seventy-two-inch reflecting telescope, the largest yet completed, has just been finished by the Warner & Swasey Company, Cleveland, Ohio.

This instrument, which was built for the Dominion Astronomical Observatory, Victoria, British Columbia, is of the equatorially mounted type, supported at the north and south ends by bearings in a direction parallel to the axis of the Earth. The declination axis to which the tube is attached at ninety degrees passes rectangularly through the central cubical portion of the polar axis. The weight of the telescope is fifty-five tons, and will be borne by concrete piers. A precision driving clock moves the instrument in right ascension through an accurately cut worm wheel, nine feet in diameter on the polar axis.

The telescope is moved from one position to another, and is set and guided by seven electric motors. The seventy-two-inch mirror and optical accessories were made by the J. A. Brashear Company, Pittsburg. The revolving dome, built by the Warner & Swasey Company, is sixty-six feet in diameter, and weighs one hundred and twenty tons. It has a double shutter, with an opening fifteen feet wide, and all movements, including revolution, operation of shutter and wind shield, and control of the observing bridge, are effected by electric motors.

The Times, July 19th.

THE LARGEST TELESCOPE.

To the Editor of The Times.

SIR,—I have read with interest the description which appeared in your issue of yesterday's date of what you characterise as "The Largest Telescope in the World," which has been constructed for Dominion Astronomical Observatory, Victoria, British Columbia. I venture to correct your statement that the reflecting telescope in question is the only one in existence which has a mirror of seventy-two inches in diameter, and explain that my late father, the third Earl of Rosse, completed his great reflecting telescope in 1840, which was erected at the observatory at Birr Castle, Ireland, in that year, having a mirror of the same size. A detailed description of this telescope appears in the *Transactions of the Royal Society* for that year. Recently the present Earl of Rosse presented to the authorities of the Science Museum, South Kensington, one of the mirrors of that great telescope, together with the tools used in grinding and polishing the reflecting surface. The undersigned accordingly undertook to convey them from the observatory at Birr Castle to the Science Museum, which was successfully accomplished, and they are exhibited there, together with a model of the telescope complete, as it was then erected. This mirror with the truck on which it rests weighs approximately five tons, and as the metal of which it is constructed is extremely brittle very special precautions were required against fracture during transit. It is interesting to note that, although seventy-six years have now elapsed, and in the interval many attempts have from time to time been made to produce larger telescopes than this, it is only now that one of even equal size has been constructed.

I remain, yours faithfully,

ATHENAEUM, July 20th. R. C. PARSONS.

The Times, July 21st.

THE BLINK MICROMETER FOR DETECTING PROPER MOTIONS.—The study of the proper motions of the stars is of primary importance in solving the problem of the structure of our stellar system. The old method of determining them was by meridian observations, separated by as wide an interval as possible. This method still holds the field for fundamental stars, which may be taken as those visible to the naked eye. Indeed, down to the ninth magnitude it has not been superseded, except in the case of a few stars of very large motion. The positions and proper motions of all the stars in the northern hemisphere that are of the ninth magnitude, or brighter, will be known in the next few years with sufficient accuracy to use them as index points on stellar photographs, from which the positions and motions of the fainter stars can be deduced. In order to do this in a wholesale manner it will be necessary to make careful measures of the positions of all the stars; but various short-cuts have been tried for detecting stars that have considerable motion. One method is simple superposition of plates taken at different dates. Another compares the plates by a stereoscope, when any star with large motion appears to stand out in relief either above or below the level of the rest. The effect is not very good, unless the motion is nearly parallel to the line joining the centres of the plates. Moreover, it is found that the different arrangement of the silver grains in the images on the two plates sometimes gives a spurious impression of relief. The Blink method has proved the most successful. By means of mirrors the image of either plate can be brought into the field of view, and one can pass rapidly from one to the other, and back again. If any star has sensibly changed its place between the exposures, its image appears to jump to and fro when the change is made. The effect is found to impress itself on the eye more readily than in the other methods. Mr. Innes, at Johannesburg, is examining the Franklin-Adams plates of the southern sky. I have already referred to his discovery of a faint star near Alpha Centauri that is moving 5″ per annum. The method is also being used at Yerkes Observatory. I mentioned last month Professor Barnard's discovery of a star with the unprecedented motion of 10″ per annum. Several other proper motions have been found there. One of them belongs to a very faint star whose magnitude is 15. These faint stars, with large motions, must be very non-luminous bodies—perhaps one-hundredth or one-thousandth of the luminosity of our Sun. They are probably near the end of their career as suns, and are approaching extinction. It seems to be a reasonable conclusion that a still greater number of stars has passed beyond the luminous stage, and are wholly dark. Where these dark orbs are revolving round luminous ones their presence can be detected by the gravitational disturbances they produce. It will be remembered that the companions of Sirius and Procyon were announced in this manner before they were visually detected. In other cases there would seem to be no possibility of detecting these dark stars unless one should pass near enough to our system to become visible by reflected light. That would probably be a very rare occurrence.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

MANUFACTURE OF CHEMICAL FILTER PAPER.—A recent issue of *The Analyst* (1916, XLI, 159) contains an interesting paper, by Messrs. Bevan and Bacon, describing the steps which have been taken to supply the want of chemical filter paper in this country. It is estimated that, prior to the war, upwards of six hundred thousand pounds were imported, mainly from Germany. At the present time four English manufacturers are producing filter paper of all grades, and papers equal to any foreign quality are now obtainable.

For most purposes filter papers should have the property of "softness," or what is technically known as "bulk." This means, in other words, the relationship between the volume of paper and the volume of fibre. For a fairly rapid paper the bulk should be about 3·5 (fibre = 1). The other physical character required is a high degree of elasticity, so as to stand the strain of liquid forced through the paper under pressure. The occurrence of pinholes in papers of medium bulk is not infrequent, and is due to faulty manipulation of the material at the mill.

The cellulose derived from cotton is preferable to that obtained from flax owing to its being less liable to undergo hydration. The chief inorganic impurities in filter paper are lime and iron oxide. The former is mainly derived from salts in the water, but is also due to chemical operations, such as the bleaching. Iron is derived from metallic impurities in the rags; while silica and alumina, which are sometimes found, are attributable to the rays having been loaded with kaolin.

The only common organic impurities are starch and oil. Starch is generally present as dressing in old rags, but is to a large extent removed when the rags are boiled with alkali. As a rule, the oil in filter papers does not exceed 0·07 to 0·084 per cent., although the raw material may contain as much as one per cent. This, too, is removed by the alkali treatment.

CALCIUM HYPOCHLORITE AS A SEED STERILISER.—Mr. J. K. Wilson has made a study of the relative efficiency of various disinfecting agents for sterilising seeds (*Bull. Agric. Intell.*, 1916, VII, 216). He finds that the most satisfactory results are obtained by the use of ordinary bleaching powder, a solution of which is prepared by mixing ten grammes of the commercial product (containing twenty-eight per cent. of available chlorine) with one hundred and forty cubic centimetres of water, and allowing the mixture to stand for five to ten minutes. The clear solution, which will then contain about two per cent. of available chlorine, is used to treat about five times its volume of the seed. The length of treatment required varies considerably with the kind of seed. Thus wheat requires more than twelve

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hours' treatment, whereas half that time is sufficient for alfalfa. Any traces of hypochlorite left on the seed have no injurious effect upon the vitality, provided that the treatment has not been unnecessarily long.

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., D.Sc.

PERU.—Several recently published papers deal with the work of the expeditions sent to Peru under the auspices of the National Geographic Society and Yale University. In one of these (*Amer. Jour. Sci.*, XLI, page 1) H. E. Gregory discusses in detail the physiography of the Cuzco Valley. The chief agent in the erosion of the country has been ground water, the activity of which is intensified by the high gradients and the open joints and calcareous cement of the underlying rocks. The mountains have undergone several cycles of erosion. The subdued relief of the Inca peneplain indicates maturity, but the youthfulness of the higher peaks is shown by the abrupt scarps and sharp cañons. The streams are mainly consequent, and, as is to be expected, the influence of structure is not in evidence. Most of the larger ones seemed to have been initiated on the Inca peneplain, but the original drainage has been greatly modified by uplift, by the warping and faulting which accompanied the uplift, and possibly by igneous intrusions. Most of the streams may be divided into three parts: an upper mature valley, an intermediate torrential portion with a steep grade, and a lower cañon entrenched in Pleistocene gravel. The intermittent nature of post-Glacial erosion is shown by the large number of well-developed terraces.

A large lacustrine deposit indicates the position of a former lake. This was initiated in a depression, due to faulting, in early Pliocene times, and the area had reached an advanced stage of degradation before the Glacial period. Aggradation in Pleistocene times raised the level of the floor and the lake was finally drained by the intermittent down-cutting of the outlet stream. Remarkable pseudo-Glacial striae, originating by faulting, were noticed in several places. The evidence of erratics, moraines, cirques, and so forth, suggests thirteen thousand feet as the general altitude of the Pleistocene snow-line, though valley-forms are often the only evidence of glaciation.

Two profusely illustrated papers in *The National Geographic Magazine* (May, 1916) deal with the 1915 expedition. H. Bingham gives an account of the archaeological results; while O. F. Cook describes his investigations into the agricultural methods of the early Peruvians. The large run-off, on a mature topography, renders the soil very unstable, and this has been counteracted by the construction of elaborate terraces.

GEOLOGY.

THE FLOATING REED-FEN OF THE DANUBE.—*The Journal of the Linnean Society* for July, 1916, contains an interesting paper, by Miss Marietta Pallis, on the reed-fen of the Danube. The reed (*Phragmites*) forms large floating masses, which at first are attached to the shore, but not infrequently become completely detached, and form true floating islands. In itself the paper is purely botanical, but it affords food for thought also to the geologist in view of its possible bearing on the origin of certain kinds of coal. These masses of floating Plav, as they are called in Roumania, contain an enormous amount of vegetable matter, and they seem to be formed best in water which does not contain much silt. Hence it is conceivable that large quantities of living plants, free from sand and mud, might be carried out to sea by a sudden flood. The plants would presumably be killed by the salt water. When decay began they would sink to the bottom, and would eventually be buried by a covering of marine sediment. It is, of course, quite clear that reeds and flowering plants in general did not exist in Carboniferous times; but, as Nature has a way of repeating herself, it is possible that some other types of plant, such as horse-tails or club-mosses, might have developed similar habits at this early date. Furthermore, the whole process may be applicable to the formation of some of the coals of the Tertiary period, when the vegetation was essentially the same as it now is. R. H. R.

THE RECENT ACTIVITY OF LASSEN PEAK, CALIFORNIA.—This old volcano at the southern end of the Cascade range has shown a remarkable revival of activity during the last two years. As set forth by Dr. Diller in a paper in *Science* for May 26th, 1916, the volcano first originated in the Eocene period, and carried on its activity during the Miocene and Pliocene, but settled down to a state of quietude in Pleistocene and Recent times. The mountain has four craters, of which the second is responsible for the present cone; the third broke out near the foot some centuries ago; while the fourth is the new one formed first in 1914. This crater is situated inside the second at the summit of the mountain. At first it was quite small, but is now more than one thousand feet across, and occupies more than half the area of the old crater. In 1914 the eruptions were entirely explosive, the products being chiefly rock fragments, some of which were many tons in weight. In May, 1915, however, lava rose in the pipe, and overflowed at one place through a notch in the rim of the old crater, forming a flow about a mile long. At the same time a lid of solid lava was formed over the crater. This was lifted some days later, and a hot blast, resembling that of Mount Pelée, escaped, and rushed down the mountain, devastating about ten square miles of country, large trees up to three feet in diameter being uprooted. Since then not much activity has been observed, and it seems likely that the period of eruptions is drawing to a close.

W. H. W.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

"OLD PROBS."—Professor Cleveland Abbe, in *The Scientific American* for May 20th, has an interesting article on "How the United States Weather Bureau was Started." In his inaugural address at Cincinnati on May 1st, 1868, he stated that with a proper system of weather reports much could be done for the welfare of man, and astronomy also could be benefited. This suggestion was taken up by Mr. John Gano, the President of the local Chamber of Commerce. A committee approved Professor Abbe's plans and promised the expenses of the first trial. The first number of *The Cincinnati Weather Bulletin* was issued on September 1st, 1869. It contained only a few observations telegraphed from distant observers, and announced "Probabilities" for the next day. Professor Abbe says that this bulletin, in his own handwriting, was posted prominently in the hall of the Chamber, but unfortunately he mad misspelled Tuesday, and he soon found below his "Probabilities" the following humorous line by Mr. Davis, the well-known packer: "A bad spell of weather for Old Probs." This established his future very popular name of "Old Probs." These forecasts were very kindly treated by all, and soon led to a desire that the Federal Government should develop the Cincinnati enterprise and make it useful to the whole country. The result was that on February 9th, 1870, the Secretary of War was authorised to carry out this new duty, and he entrusted the same to the Chief Signal Officer, U.S.A. (General A. J. Meyer). Professor Abbe's work in connection with the Weather Bureau of the Army Signal Service began on January 3rd, 1871. After a month's practice it was decided that his forecast would evidently more than fill the popular expectations, and tri-daily publications began at once. The term "Probabilities" then became official, as it had begun in September, 1869, and in those days it was appropriate; but the word "Forecast" has long since been substituted.

It may be mentioned that Professor Abbe still continues his connection with the U.S.A. Weather Bureau.

XUM

MICROSCOPY.

By F.R.M.S.

QUARTZ AND ITS MOBILE BUBBLES.—Microscopists who wish to secure a good example of quartz showing mobile bubbles in its numerous liquid-containing cavities are often unaware that there is no need for the laborious process of grinding a section, nor need one go further than the gravel walk to get specimens of quartz that will show the phenomenon. The white stones that lie plentifully enough in any garden, or even the tiny translucent grains of quartz in every flower-bed, all contain moving bubbles, which can readily be prepared for microscopic observation.

But these grains and pebbles, though they show the phenomenon when appropriately treated and examined, do not afford such an abundance of mobile bubbles as the quartz nodules that can be found at some depth in the soil in a gravel-pit section. The surface stones seem to have lost some of the liquid carbonic acid which quartz contains in its cavities. Possibly exposure enables it to escape gradually in course of ages. Anyhow, the fact remains that there is a greater abundance of liquid in some quartz pebbles than in others, and especially in specimens of the rock gathered at some depth from the surface. Minute as the cavities are, it must be remembered that the carbonic acid they contain, being liquid, is capable of considerable expansion on its release and conversion into the gaseous state.

Take from the sand-pit a nodule of quartz, of which plenty will be at hand, and break it up with a hammer. Select one of the shining white pieces from the interior, and, wrapping it in a piece of paper, smash it with a smart blow from the hammer into much smaller fragments. Pound these in a stone mortar with some water till they are quite fine, and wash well in three or four changes of water. Nearly every flake of the sediment, when viewed under a power of from two hundred and fifty to five hundred diameters, will be seen to be full of cavities containing liquid, and in most of them there will be observed a tiny bubble of gas. A large proportion of the bubbles will be seen to be in motion—the well-known Brownian movement—and the smaller they are the more rapidly they dart from side to side of the cavity.

With a one-twelfth-inch power, oil immersion, and a dark-ground illumination the phenomena presented by the bubbles in the smaller cavities are amazing, and it is almost difficult to realise that one is not looking at living organisms.

The flakes may be mounted in balsam, though I prefer gum kauri or gum mastic.

Pounded quartz from some specimens of granite is also admirable for showing mobile bubbles. The quartz from the china clay beds contains bubbles of all sizes, some, which are much too large for automatic movement, being visible with a single lens. Agates, opals, topaz, and many other stones have liquid inclusions.

One rather puzzling feature of the phenomena is the fact that in some cavities stationary bubbles will be seen no larger than those that move. The difference seems to be independent of the shape of the cavity, which is very varied. If we are to accept Jean Perrin's hypothesis of the Brownian movement, which attributes it entirely to the molecular agitation of the suspending liquid due to heat, these stationary bubbles are anomalous. It will be found, moreover, that, as a general rule, the bubbles contiguous to one that moves are also mobile, as though the stimulus, whatever it may be, were localised in different areas of the quartz. Indeed, some specimens of quartz show plenty of bubbles, but practically all are motionless. It would be too much to assume that some form of radio-activity is present in varying degree in different parts of the rock or ts liquid inclusions, and that its absence in other areas is the cause of the immobility; yet such a possibility seems worth investigating. It could perhaps be tested by bringing a flake that shows a group of mobile bubbles into close proximity with one in which the bubbles are motionless—a delicate, but not impracticable, operation.

It may be incidentally mentioned that the method of pounding into thin flakes is often a very effective way of preparing rocks for microscopic examination, and it frequently exhibits details of structure practically as well as a section.

Figure 158 shows the appearance of the quartz flakes with their cavities and bubbles, as seen with a quarter-inch objective. The drawing was made with the camera lucida, the original (somewhat reduced in reproduction) giving a magnification of four hundred and seventy-five diameters.

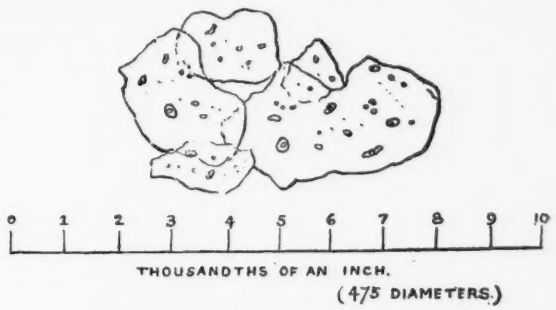

FIGURE 158.

Mobile Bubbles in quartz. The largest are about $\frac{1}{1000}$-inch in diameter.

C. E. BENHAM.

PHOTOGRAPHY.

By EDGAR SENIOR.

ACID VERSUS ALKALINE FIXING BATHS.—Acid fixing baths, which are so largely employed at the present time, are not generally to be recommended, and in many cases they have no advantage whatever. They were originally introduced for the purpose of removing any stain or deposit from negatives developed with pyro, but even this has been shown to be better accomplished by the use of an alkaline solution; and with the introduction of non-staining developers the object of their use disappeared. It may therefore be said that the sole advantage of acid fixing baths to-day appears to be their action in effectually stopping any further developing action on gaslight and similar papers, which are apt to show signs of over-development if placed straight into a bath of plain "hypo." Some acid baths that have been recommended, however, have a tendency to deposit sulphur in the film, which eventually gives rise to fading of the image. Then, again, negatives or prints that have been fixed in an acid fixing bath require longer washing, to remove the soluble salts from the film. In the case of the multiple coated plates, issued years ago by the late Mr. J. T. Sandell, the acid fixing bath recommended in order to harden the films, and so prevent their separating during the washing, necessitated the latter operation to be prolonged in order to eliminate the soluble silver salts and "hypo" from the films. Although an acid bath keeps clean much longer than a plain or alkaline one, it does not follow that it will perform its function as a fixing agent any better; in fact, its very appearance may be the cause of danger, if proper attention be not given to the strength of the solution and the number of plates or prints that are fixed in it. A discoloured bath would thus have the

advantage that it would be replaced by a fresh one at more frequent intervals. When a fixing bath is required that will remain free from discoloration for some little time, the writer has always found the one made up according to the following formulae satisfactory :—

Sodium thiosulphate (" hypo ") ...	5 ounces
Sodium sulphite	1 ounce
Water	20 ounces

A solution of " hypo " made up according to the above formula (due to Mr. William Bell) has the property of fixing negatives, as well as bromide and gaslight prints, quite free from any stain or discoloration whatever. The use of an alkaline instead of a acid solution of " hypo," however, has many advantages, and as far back as 1894 Mr. Chapman Jones definitely advised an alkaline fixing bath, and Mr. Alfred Watkins, writing in *The British Journal of Photography* on July 7th last, endorses this advice, and recommends photographers to avoid the use of acid baths for fixing either negatives or prints. To those who may desire to replace their acid fixing bath by an alkaline one, the following formulae, given by Mr. Godfrey Wilson in *The British Journal of Photography* of July 28th, 1916, can be recommended :—

ALKALINE FIXING BATH.

Sodium thiosulphate (" hypo ") ...	4 ounces
Sodium sulphate	¼ ounce
Sodium carbonate	30 grains
Water	20 ounces

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

SPECTRO-PHOTOGRAPHY.—Workers in this department of physics have often longed for an ideal photographic emulsion of uniform sensibility throughout its chief range of sensitiveness and an illuminant emitting equal amounts of energy of all wave-lengths to which the emulsion is chiefly sensitive. The results obtainable from such an imaginary combination can be attained readily by the remarkably elegant device communicated by Lukiesh to *The Astrophysical Journal* for May, 1916. The method consists of making a spectro-photographic filter through which the spectra are photographed. A photographic plate, which is to be employed for spectro-photography, is placed, glass forwards, in the spectrograph, and on it is photographed the spectrum of a light source, yielding a continuous spectrum such as a tungsten lamp. This plate is now to be developed, fixed, dried, and put back in the spectrograph. It constitutes the requisite filter. Another plate of the same emulsion is placed, film to film, on the first plate, and if the filter has been correctly exposed will give results—in experiments on absorption, for instance—similar to those which would be produced with the ideal emulsion and the ideal source of light.

CRYSTAL DETECTORS.—In wireless telegraphy the electrical oscillations in the aërial at the receiving station, due to the action of the waves from the sending station, must be made to give audible or visible signals in order that the message can be received. Most receivers are such that the signals are sounds in an ordinary telephone. The wave-detectors used in connection with the telephone are generally either electrolytic or crystal detectors. Crystal detectors are formed by the contact of a crystalline body with another crystalline body, or with a metal. The contact thus formed exhibits the effect known as " unilateral conductivity," that is, the current can flow through the contact more readily in one direction than in the other. When the contact is subjected to alternating electromotive forces of high frequency by being included in the aërial circuit at the receiving station, currents pass through the contact in one direction more than in the other, and if a telephone receiver is joined up in parallel to the contact it will give a sound whenever a group of waves is received.

BROMINE AS A LIGHT FILTER.—R. W. Wood has been recently extending his work on the monochromatic photography of the Moon and planets (*Astrophysical Journal*, May, 1916). In the earlier experiments made several years ago he used for the ultra-violet ray-filter a rather thick deposit of metallic silver on a thin plate of quartz, or uviol glass. Silver films are, however, extremely opaque to the selectively transmitted region, which lies between three thousand and three thousand two hundred tenth-metres, so much so that an exposure of two or three minutes is required for the full Moon. With bromine vapour he finds that a fully exposed plate can be obtained in eight or ten seconds ; and if, in addition, a thin cell, filled with very dilute potassium chromate be used, the transmitted region is practically the same as a silver film, but of about tenfold intensity.

RADIO-ACTIVITY.

By ALEXANDER FLECK, D.Sc.

The August issue of *The Philosophical Magazine* contains two papers by Mackower, to which attention should be directed. The first deals with the—

STRAGGLING OF α PARTICLES, the experiments being carried out by a photographic method in place of the use of scintillations on a zinc sulphide screen. The source of α rays used was radium-C on a wire lying across the space between, and perpendicular to, two heavy parallel brass plates, supported at a distance of one millimetre apart. The α rays were allowed to fall on a Schumann photographic plate, which had an extremely thin sensitive film, and which was placed at some fixed distance in a plane parallel to the active wire.

After a suitable exposure the plate was developed and examined with a reading microscope, and the numbers of silver grains produced in certain successive areas were counted. From the numbers so obtained, it was possible to calculate the number of α particles reaching the plate at successive distances from their source, and to draw a curve showing the change of the number of α particles ceasing to exist as the distance from the source became greater. The curve obtained by this method lies much closer to the curve calculated from theoretical considerations only than the curve obtained by the scintillation method, although the first two are by no means coïncident. The straggling actually obtained is greater than the calculated amount should be. The author suggests two main causes for this discrepancy: (1) The fact that the photographic film, though thin, is still of finite thickness ; and (2) the fact that the surface emitting the radiations will not be free from imperfections. This work, as almost all work involving the counting of α rays or their effects, must have been exceedingly laborious, each point on the curve being obtained as the result of counting between four hundred and seven thousand silver grains.

The second paper deals with the—

EFFICIENCY OF THE RECOIL OF RADIUM-D. —From comparatively simple considerations, it is shown that the efficiency of the recoil of radium-B from radium-A should be greater than the efficiency in the case of radium-D from radium-C, on the assumption that the whole of the active deposit is grown *in situ* direct from the emanation.

If one radio-element is disintegrating on a surface, the greatest possible percentage of the element recoiled which can be collected on a charged plate is fifty per cent. of the element formed. Mackower has made experiments, and finds that the average per cent. of radium-D which can be collected by recoil is 34·35. This value was obtained by measuring the activities due to polonium on the active plates after an interval of three months. From this value it is calculated that the " range " of the recoil radium-A atom is 0·626 time that of the recoiled radium-C. This value is lower than the ratio of the ranges of the α particles from the same elements by about fifteen per cent.

ZOŌLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

DO BEES TASTE THEIR FOOD?—There is a well-known difficulty in distinguishing between taste and smell. Some kinds of food that seem to have no odour, or very little, have a pronounced odour when eaten. The odorous particles are not given off until the food is taken into the mouth and mixed with saliva. Dr. N. E. McIndoo, of the Bureau of Entomology, Washington, has been experimenting with bees, and finds that their highly developed olfactory organs are sufficiently capable of receiving odours, however weak, from any substance. When the odours are extremely weak the bees have to eat some of the food first, and then the olfactory pores near the mouth are affected. The so-called taste of bees is only a phase of smell. After once refusing foods which contain undesirable substances emitting faint odours, bees seem to discriminate, and will seldom eat more if there is anything else available.

FAUNA OF JORDAN SYSTEM AND LAKE OF TIBERIAS.—Dr. Nelson Annandale finds that most of the fauna of this area is Palaearctic, coming from the north and east in comparatively recent times, and also, in a few cases of amphibious creatures, from the Nile. There is, however, a distinct Ethiopian element, consisting exclusively, or almost exclusively, of fishes belonging to families which possess an extraordinary vitality, and have very special powers of physiological adaptation to environment. The absence or paucity of Ethiopian invertebrates may be due to a blocking of the outlet of the Lake of Tiberias, and a consequent fatal increase in the salinity. The origin of the Ethiopian element in the fauna is explained by the existence in Pliocene times of a river flowing southwards into the Indian Ocean from what is now the Jordan system.

FOWL MITE ATTACKING MAN.—The domestic fowl harbours in warm countries a blood-sucking mite, called *Liponyssus bursa*, which has been recorded, as Mr. Stanley Hirst reports, from Africa, Mauritius, China, India, the Bahamas, Buenos Aires, Sydney, and so on. In several instances, notably in Sydney, the mite has been known to pass on to man, producing a rash. It is possible that the wide distribution of this mite is due to its being carried about by the common sparrow. It seems that the European fowl mite (*Dermanyssus gallinae*) does not thrive in tropical and sub-tropical countries.

PURRING AND ROARING.—Sir Richard Owen pointed out that there was a connexion between the resonance of the lion's voice and the looseness of the hyoid. Mr. R. I. Pocock, Superintendent of the "Zoo," notes that the same applies to the tiger, whose roar is a sexual call. The roars of jaguar and leopard are like "hoarse, barking coughs, an interval of about one second separating each expiratory effort." They may be mimicked by sawing a piece of thin wood with a coarse-toothed saw. The call of the cheetah is a most decided mew. Mr. Pocock finds that those Felidae that have an elastic ligament between the ceratohyal and the upper elements of the suspensorium (lion, tiger, leopard, jaguar) *roar*, but never purr; while all the other species of Felidae, with normally constructed hyoids, *purr*, but never roar (cheetah, puma, caracal, and so on). The hyoid apparatus of the ounce is like that of the lion, but the voice is not known to Mr. Pocock.

MENDELISM AND MAN'S WELFARE.—In his valuable "Manual of Mendelism" (1916) Professor James Wilson gives some vivid instances of what the applications of genetics might do for our national welfare if there were more practical faith in science. "The average yield of wheat in Britain is about thirty-two bushels to the acre. It might be raised to forty, or even fifty. For every day by which the life of a variety of wheat is shortened between seed time and harvest the wheat-growing area in Canada reaches fifty or sixty miles farther northwards. A vigorous, early ripening, and highly productive oat, together with a turnip having the same characters, might increase the returns from many a northern or high-lying farm in Britain, and might even be the means of causing many a pasture field to revert once again to the plough." The work done in Denmark shows how the wealth of this country, so far as it proceeds from dairy cattle, might be very nearly doubled

THE INERTIA OF INHERITANCE.—Dr. Drinkwater, who has given much attention to the inheritance of peculiarities in fingers, reports a case where the index and middle fingers were reduced so that the ring finger projected. At the base of the index and middle fingers on both hands there was a small extra triangular bone. Now this trivial peculiarity was found persistent—with the usual inertia of a Mendelian character—for at least four generations. The family studied had thirty-six descendants, fifteen of whom had the abnormality. The peculiarity, being Mendelian in its behaviour, was not exhibited by the descendants of normal members of the lineage.

STORES OF LIVING BLOOD.—There is perhaps a hint of something which will mean much in days to come in the success that has attended certain experiments made by Drs. Rous and Turner in "keeping" the blood of the rabbit alive outside of the body. The red blood-corpuscles lived for a fortnight in mixtures of blood, sodium citrate, saccharose, and water, and transfusion experiments showed that the reintroduced corpuscles remained in circulation and function. It may be that "kept" human cells could be similarly used to replace lost blood. There are many facts accumulating which indicate that the possibilities of putting the broken "Humpty Dumpty" of life "together again" are greater than has been supposed.

CORRESPONDENCE.

ON THE THEORETICAL POSSIBILITY OF PRODUCING LIVING LIFE-FORMS.

To the Editors of "KNOWLEDGE."

SIRS,—Stephen Le Duc has succeeded in producing more or less inorganic life-forms and more or less living ones. The expression "inorganic life-forms" is in reality a contradiction in terms. When so-called inorganic matter produces life-forms they are necessarily organic, the essence of a life-form being that it is organised. The phrase really means organic life-forms composed of chalk or some other materials, instead of carbon, nitrogen, hydrogen, and oxygen, and so on, in the proportions in which they occur in living beings.

When a chemist produces a new chemical compound, his part in the creation of it is really a very insignificant one. He really merely brings together certain groups of reagents under certain conditions, which usually do not occur in nature under such conditions in contact with one another, and their reaction results in the so-called new substance.

J. C. Bose has proved that there is no hard-and-fast line between organic and inorganic matter. Both human beings and metals are poisoned by the same drugs, and respond similarly to the same stimuli. Consequently when the right "inorganic" materials are brought together under the right conditions living beings will be produced, but the part human agency will have had in the performance will remain, as in the case of new chemical compounds, an extremely limited one.

W. W. STRICKLAND, B.A.,
LESTRI LEVANTE. Trin. Coll., Cambridge.

XUM

THE FACE OF THE SKY FOR OCTOBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 44.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Oct. 2.....	12 32·9	S. 3·6	16 46·7	S. 25·8	12 51·5	S. 8·7	9 44·8	N. 13·0	2 5·7	N. 11·1	8 5·0	N. 20·4	21 14·8	S. 16·7	8 27·2	N. 18·9
„ 7.....	12 51·1	5·5	21 42·2	S. 11 3	12 32·8	5·1	10 6·4	11·5	2 3·4	10·9	8 6·4	20·3	21 14·4	16·8	8 27·6	18·9
„ 12.....	13 9·5	7·4	2 0·2	N. 17·5	12 21·7	2·1	10 28·2	9·9	2 1·0	10·7	8 7·7	20·2	21 14·2	16·8	8 27·9	18·9
„ 17.....	13 28·1	9·2	6 30·8	N. 24·8	12 25·5	1·2	10 49·9	8·1	1 58·5	10·5	8 8·7	20·2	21 14·0	16·8	8 28·2	18·8
„ 22.....	13 46·9	11·0	10 28·3	N. 5·9	12 42·5	2·4	11 11·8	6·2	1 56·0	10·2	8 9·6	20·2	21 13·9	16·8	8 28·4	18·8
„ 27.....	14 6·0	S. 12·8	14 31·7	S. 19·9	13 7·3	S. 4·9	11 33·6	N. 4·1	1 53·4	N. 10·0	8 10·3	N. 20·1	21 13·8	S. 16·8	8 28·6	N. 18·8

TABLE 45.

Date.	Greenwich Noon. Sun. P	B	L	Jupiter. P	B	L_1	L_2	T_1	T_2	Midnight. Moon. P
	°	°	°	°	°	°	°	h. m.	h. m.	°
Oct. 2 ...	+26·2	+6·6	282·3	Oct. 2 ...	−21·0	+3·3	43·3	177·5	0 58 *m*	7 6 *m*	Oct. 2	+ 5·4
„ 7 ...	26·4	6·3	216 4	„ 9 ...	21·3	3·3	69·6	150·4	0 15 *m*	7 51 *m*	„ 7	−19·4
„ 12 ...	26·4	6·0	150·4	„ 16 ...	21·5	3·3	95·9	123·3	9 22 *m*	8 36 *m*	„ 12	−19·1
„ 17 ...	26·2	5·6	84·4	„ 23 ...	21·7	3·3	122·2	96·2	8 40 *m*	9 21 *m*	„ 17	+ 4·1
„ 22 ...	25·9	5·2	18·5	„ 30 ...	−21·9	+3·2	148·4	69·0	7 57 *m*	0 10 *m*	„ 22	+21·3
„ 27 ...	+25·3	+4·7	312·6								„ 27	+17·0

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone; System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}4$, $9^h\ 55^m{\cdot}6$ respectively.

The data for the Moon in Table 45 are given for Greenwich midnight, *i.e.*, the midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving rapidly Southward. Its semi-diameter increases from 16′ 0″ to 16′ 9″. Sunrise changes from $5^h\ 59^m$ to $6^h\ 53^m$; sunset from $5^h\ 41^m$ to $4^h\ 35^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is an evening star at the beginning of the month, in inferior conjunction on the 5th, then a morning star. It reaches elongation, 18° West of Sun, on 20th. Semi-diameter diminishes from 5″ to 3″. Illumination very small at beginning of month, $\frac{8}{9}$ at end.

VENUS is a morning star, well placed for observation. It passed elongation, 46° West of Sun, on Sept. 12th. Near Moon on morning of 23rd. The semi-diameter diminishes from 10″ to 8″. Illumination of disc increases from $\frac{3}{5}$ to $\frac{7}{10}$.

THE MOON.—First quarter $4^d\ 11^h\ 0^m\ m$; Full $11^d\ 7^h\ 1^m\ m$; Last quarter $19^d\ 1^h\ 9^m\ m$. New $26^d\ 8^h\ 37^m\ e$. Perigee $6^d\ 10^h\ e$. Apogee $19^d\ 5^h\ m$. Perigee $31^d\ 7^h e$. Semi-diameter 16′ 14″, 14′ 48″, 16′ 12″ respectively. Maximum librations 11^d 7° S., 13^d 6° W., 25^d 5° E., 26^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 46.)

TABLE 46. Occultations of Stars by the Moon, visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1916.			h. m.	°	h. m.	°
Oct. 1 ...	48 B Scorpii	4·9	4 52 *e*	104	6 4 *e*	269
„ 4 ...	208 B Sagittarii	6·1	8 0 *e*	106	8 56 *e*	216
„ 9 ...	22 Piscium	5·8	9 36 *e*	127	9 58 *e*	163
„ 11 ...	101 Piscium	6·2	9 40 *e*	56	10 51 *e*	242
„ 14 ...	66 Arietis	6·1	0 12 *m*	89	1 25 *m*	231
„ 19 ...	217 B Geminorum	6·3	3 20 *m*	126	4 37 *m*	269
„ 20 ...	WZC 608	7·2	—	—	5 59 *m*	339
„ 22 ...	BAC 3529	7·0	—	—	5 7 *m*	287

From New to Full, Disappearances occur at the Dark Limb; from Full to New, Reäppearances.

MARS is low in the West and practically invisible.

JUPITER is in Aries; reaches opposition on 24th. Equatorial diameter 49″, Polar 46″. Defect of illumination practically zero.

Configuration of satellites at $11^h\ 30^m$ *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
Sept. 30	2 ○	134	Sept. 16	3 ○	124
Oct. 1	13 ○	24	,, 17	321 ○	4
,, 2	3 ○	4	,, 18	32 ○	14
,, 3	321 ○	4	,, 19	1 ○	324
,, 4	3 ○	14	,, 20	⊙	234
,, 5	○	234 1●	,, 21	2 ○	134
,, 6	12 ○	43	,, 22	1 ⊙	24
,, 7	24 ○	13	,, 23	3 ○	12
,, 8	413 ○	2	,, 24	34 ○	
,, 9	43 ○	3	,, 25	432 ○	1
,, 10	4321 ○		,, 26	41 ○	32
,, 11	4 ○	1	,, 27	4 ○	123
,, 12	41 ○	32	,, 28	42 ○	3 1●
,, 13	41 ⊂	3	,, 29	41 ○	3 2●
,, 14	24 ○	13	,, 30	43 ○	12
,, 15	13 ○	4	,, 31	3124 ○	

IV. is due south of the disc on the 23rd.

The following satellite phenomena are visible at Greenwich:—$3^d\ 5^h\ 23^m$ *m* II. Sh. I., $5^h\ 57^m$ *m* I Sh. I.; $4^d\ 3^h\ 10^m\ 51^s$ *m* I. Ec. D., $5^h\ 52^m$ *m* I. Oc. R.; $5^d\ 0^h\ 4^m\ 16^s$ *m* II. Ec. D., $0^h\ 5^m\ 5^s$ *m* III. Ec. D., $0^h\ 26^m$ *m* I. Sh. I., $0^h\ 56^m$ *m*, I. Tr. I., $1^h\ 57^m\ 43^s$ *m* III. Ec. R., $2^h\ 33^m$ *m* III. Oc. D., $2^h\ 36^m$ *m* I. Sh. E., $3^h\ 4^m$ *m* I. Tr. E., $3^h\ 30^m$ *m* III. Oc. R., $3^h\ 34^m$ *m* II. Oc. R., $9^h\ 39^m\ 29^s$ *e* I. Ec. D.; $6^d\ 0^h\ 18^m$ I. Oc. R., $6^h\ 43^m$ *e* II. Sh. I., $6^h\ 54^m$ *e* I. Sh. I., $7^h\ 22^m$ *e* I. Tr. I., $7^h\ 42^m$ *e* II. Tr. I., $9^h\ 4^m$ *e* I. Sh. E., $9^h\ 19^m$ *e* II. Sh. E., $9^h\ 32^m$ *e* I. Tr. E., $10^h\ 11^m$ *e* II. Tr. E.; $7^d\ 6^h\ 44^m$ *e* I. Oc. R.; $11^d\ 5^h\ 5^m\ 45^s$ *m* I. Ec. D.; $12^d\ 2^h\ 20^m$ *m* I. Sh. I., $2^h\ 39^m\ 14^s$ *m* II. Ec. D., $2^h\ 40^m$ *m* I. Tr. I., $4^h\ 7^m\ 20^s$ *m* III. Ec. D., $4^h\ 30^m$ *m* I. Sh. E., $4^h\ 48^m$ *m* I. Tr. E., $5^h\ 48^m$ *m* II. Oc. R., $11^h\ 34^m\ 25^s$ *e* I. Ec. D.; $13^d\ 2^h\ 2^m$ *m* I. Oc. R., $8^h\ 49^m$ *e* I. Sh. I., $9^h\ 6^m$ *e* I. Tr. I., $9^h\ 21^m$ *e* II. Sh. I., $9^h\ 57^m$ *e* II. Tr. I., $10^h\ 58^m$ *e* I. Sh. E., $11^h\ 14^m$ *e* I. Tr. E., $11^h\ 57^m$ *e* II. Sh. E.; $14^d\ 0^h\ 26^m$ *m* II. Tr. E. $6^h\ 3^m\ 14^s$ *e* I. Ec. D., $8^h\ 28^m$ *e* I. Oc. R.; $15^d\ 5^h\ 27^m$ *e* I. Sh. E., $5^h\ 39^m$ *e* I. Tr. E., $6^h\ 14^m$ *e* III. Sh. I., $6^h\ 54^m$ *e* III. Oc. R., $7^h\ 33^m$ *e* III. Tr. I., $8^h\ 3^m$ *e* III. Sh. E., $8^h\ 32^m$ *e* III. Tr. E.; $19^d\ 4^h\ 14^m$ *m* I. Sh. I., $4^h\ 23^m$ *m* I. Tr. I., $5^h\ 14^m\ 21^s$ *m* II. Ec. D., $6^h\ 24^m$ *m* I. Sh. E., $6^h\ 31^m$ *m* I. Tr. E.; $20^d\ 1^h\ 29^m\ 29^s$ *m* I. Ec. D., $3^h\ 46^m$ *m* I. Oc. R., $10^h\ 43^m$ *e* I. Sh. I., $10^h\ 49^m$ *e* I. Tr. I., $11^h\ 59^m$ *e* II. Sh. I.; $21^d\ 0^h\ 12^m$ *m* II. Tr. I., $0^h\ 53^m$ *m* I. Sh. E., $0^h\ 57^m$ *m* I. Tr. E., $2^h\ 35^m$ *m* II. Sh. E., $2^h\ 42^m$ *m* II. Tr. E., $7^h\ 58^m\ 19^s$ *e* I. Ec. D., $10^h\ 12^m$ *e* I. Oc. R.; $22^d\ 5^h\ 12^m$ *e* I. Sh. I., $5^h\ 15^m$ *e* I. Tr. I., $6^h\ 31^m\ 59^s$ *e* II. Ec. D., $7^h\ 21^m$ *e* I. Sh. E., $7^h\ 23^m$ *e* I. Tr. E., $9^h\ 7^m$ *e* II. Oc. R., $10^h\ 15^m$ *e* III. Sh. I., $10^h\ 45^m$ *e* III. Tr. I., $11^h\ 49^m$ *e* III. Tr. E.; $23^d\ 0^h\ 4^m$ *m* III. Sh. E.; $26^d\ 6^h\ 6^m$ *m* I. Tr. I., $6^h\ 9^m$ *m* I. Sh. I.; $27^d\ 3^h\ 20^m$ *m* I. Oc. D., $5^h\ 35^m\ 32^s$ *m* I. Ec. R.; $28^d\ 0^h\ 32^m$ *m* I. Tr. I., $0^h\ 38^m$ *m* I. Sh. I., $2^h\ 27^m$ *m* II. Tr. I., $2^h\ 37^m$ *m* II. Sh. I., $2^h\ 40^m$ *m* I. Tr. E., $2^h\ 47^m$ *m* I. Sh. E., $4^h\ 57^m$ *m* II. Tr. E., $5^h\ 13^m$ *m* II. Sh. E., $9^h\ 46^m$ *e* I. Oc. D.; $29^d\ 0^h\ 4^m\ 23^s$ *m* I. Ec. R., $6^h\ 58^m$ *e* I. Tr. I., $7^h\ 6^m$ *e* I. Sh. I., $8^h\ 51^m$ *e* II. Oc. D., $9^h\ 6^m$ *e* I. Tr. E., $9^h\ 16^m$ *e* I. Sh. E., $11^h\ 41^m\ 7^s$ *e* II. Ec. R.; $30^d\ 1^h\ 56^m$ *m* III. Tr. I., $2^h\ 16^m$ *m* III. Sh. I., $3^h\ 6^m$ *m* III. Tr. E., $4^h\ 4^m$ *m* III. Sh. E., $6^h\ 33^m\ 8^s$ *e* I. Ec. R.; $31^d\ 6^h\ 4^m$ *e* II. Tr. E., $6^h\ 32^m$ *e* II. Sh. E. Up to the date of opposition, eclipses of the satellites take place low left of the disc, taking the direction of the belts as horizontal.

SATURN is a morning star in Cancer; it is in quadrature with Sun on 23rd. Polar semi-diameter 8½″. Major axis of ring 41″, Minor 14½″. Angle P−7°·3.

East Elongations of Tethys (every fourth given) $3^d\ 1^h\cdot7$ *m*, $10^d\ 3^h\cdot0$ *e*, $18^d\ 4^h\cdot2$ *m*, $25^d\ 5^h\cdot5$ *e*; of Dione (every third given) $6^d\ 4^h\cdot6$ *m*, $14^d\ 9^h\cdot8$ *m*, $22^d\ 2^h\cdot9$ *e*, $30^d\ 8^h\cdot1$ *e*; of Rhea (every second given) $6^d\ 4^h\cdot0$ *m*, $15^d\ 4^h\cdot9$ *m*, $24^d\ 5^h\cdot8$ *m*. For Titan and Japetus E., W. denote East and West Elongations; S., I. Superior and Inferior Conjunctions. Titan $4^d\ 3^h\cdot0$ *m* E., $11^d\ 8^h\cdot1$ *e* W., $20^d\ 2^h\cdot7$ *m* E, $27^d\ 7^h\cdot5$ *e* W. Japetus $2^d\ 11^h\cdot9$ *e* S., $24^d\ 2^h\cdot1$ *m* E.

URANUS is an evening star in Capricornus. Semi-diameter 1″·8. Near Moon on evening of 6th.

NEPTUNE is a morning star in Cancer: it is in quadrature with Sun on 28th.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
July–Oct. ...	335°	+ 72°	Swift, short.
Aug.–Oct. 2 ...	74	+ 42	Swift, streaks.
Sept. 28–Oct. 9...	320	+ 40	Slow, small.
Oct. 2 ...	230	+ 52	Slow, bright.
,, 4 ...	310	+ 79	Slowish.
,, 8 ...	77	+ 31	Swift, streaks.
,, 8–14 ...	45	+ 58	Small, short.
,, 14 ...	133	+ 68	Rather swift.
,, 15 ...	31	+ 9	Slow.
,, 18–20 ...	92	+ 15	Swift, streaks.
,, 23 ...	100	+ 13	Swift, streaks.
,, 29 ...	109	+ 23	Very swift.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple

TABLE 47. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension. h. m. s.	Declination. ° ′	Magnitudes.	Period. d.	Date of Maximum.
RX Cephei	0 43 9	+81 30	7·4 to 7·9	130	1916—Nov. 3
R Piscium	1 26 15	+ 2 26	7·0 to 14·0	344	,, Nov. 4
R Arietis...	2 11 17	+24 40	7·3 to 13·2	187	,, Oct. 9
S Hydrae	8 49 8	+ 3 24	7·5 to 12·5	256	,, Oct. 2
R Ursae Maj.	10 38 42	+69 13	5·9 to 13·1	299	,, Oct. 21
S Ursae Maj.	12 40 15	+61 33	7·0 to 12·5	226	,, Oct. 21
T Sagittarii	19 11 20	−17 7	7·2 to 13·5	381	,, Nov. 7
RT Cygni	19 41 15	+48 34	6·6 to 12·2	190	,, Oct. 18
V Cephei...	23 52 21	+82 43	6·2 to 7·0	362	,, Nov. 10

Minima of Algol $3^d\ 8^h\cdot7$ *e*, $6^d\ 5^h\cdot5$ *e*, $18^d\ 4^h\cdot8$ *m*, $21^d\ 1^h\cdot6$ *m*, $23^d\ 10^h\cdot4$ *e*, $26^d\ 7^h\cdot2$ *e*, $29^d\ 4^h\cdot0$ *e*. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae $3^d\ 11^h\cdot9$ *m*, $16^d\ 10^h\cdot0$ *m*, $29^d\ 8^h\cdot1$ *m*. Period $12^d\ 22^h\cdot1$.

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interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by 9ˢ·83 per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 48.)

Observers who know Greenwich Time can use the Table to obtain their South Point.

SUN before clock October 1, 615ˢ·94; October 6, 708ˢ·03; October 11, 790ˢ·81; October 16, 861ˢ·51; October 21, 917ˢ·48; October 26, 956ˢ·64; October 31, 977ˢ·51. These are the equations of time for the moment of solar transit at Greenwich.

TABLE 48.

Day.	β Capricorni.	α Aquarii.	α Andromedae.
	S. Dec. 15° 3′.	S. Dec. 0° 43′.	N. Dec. 28° 38′.
	h. m. s.	h. m. s.	h. m. s.
Sept. 26	7 55 14·08 *e*	9 40 7·32 *e*	11 42 21·93 *e*
Oct. 6	7 15 54·83 *e*	9 0 48·32 *e*	11 3 2·90 *e*
„ 16	6 36 35·60 *e*	8 21 29·15 *e*	10 23 43·83 *e*
„ 26	5 57 16·36 *e*	7 42 9·95 *e*	9 44 24·72 *e*

VARIABLE STARS.—Stars reaching their maxima in or near October, 1916, are included. The lists in recent months may also be consulted. (See Table 47.)

REVIEWS.

ORNITHOLOGY.

A Bibliography of British Ornithology.—By W. H. MULLENS, M.A., LL.M., and H. KIRKE SWANN. Part II. 128 pages. 9-in. × 6-in.

(Macmillan & Co. Price 6/- net.)

The second instalment of this useful work is slightly larger than the first. It completes the biography of Edward North Buxton, and carries us to John Gould. Among the ornithologists considered are William Eagle Clarke, Henry Dresser, Thomas Edward, Thomas Forster, William Ward Fowler, and Giraldus Cambrensis.

We are reminded in a note that the present portion of the bibliography will be followed by a "County Index," in which will be included, not only short titles of the books, but all articles and notes in periodicals by every writer, provided that they are of a faunistic nature.

W. M. W.

PHYSICS.

Theory of Measurements: A Manual for Physics Students.—By JAMES S. STEVENS, Professor of Physics in the University of Maine. 80 pages. 9 illustrations. 6-in. × 5½-in.

(Constable & Company. Price 6/- net.)

This little book is intended for the use of students who are attending a class on methods of dealing with observations as a part of their physics course. It is not very suitable for the private student, as the numerous examples are not provided with answers, and the explanations are in some cases scanty. The last chapter—On the Methods of Constructing Empirical Formulae—consists only of eight and a half pages, and the treatment of this very important part of the subject is inadequate. The price of this book seems to us to have been fixed at a somewhat too high figure.

J. H. V.

NOTICES.

CLASSES IN PHOTOGRAPHY.—Mr. Edgar Senior's classes in photography at the South Western Polytechnic, Manresa Road, Chelsea, will begin on Monday, September 25th, at 7.30 p.m.; while the first meeting at the Battersea Polytechnic will be at the same hour on Tuesday, September 26th. This will be the elementary class, the advanced and honours class starting two days later—on Thursday, September 28th—at 7.30 p.m.

THE NATURE PHOTOGRAPHIC SOCIETY.—Details of the competition for the "Martin Duncan" Cup and the Annual Lantern Slide Competition have been issued, and can be obtained from Mr. H. Armytage Sanders, the Honorary Secretary of the Nature Photographic Society, 26, Charing Cross Road, W.C. Sets of photographs will be received until January 20th, 1917, and slides up to October 21st, 1916. Both competitions are for members of the Society only.

THE BRITISH MYCOLOGICAL SOCIETY.—The Twentieth Annual Week's Fungus Foray will be held in the New Forest from Monday, September 25th, 1916, to Saturday, September 30th. On Wednesday, 27th, Mr. E. W. Swanton will deliver his presidential address, entitled "Education in Mycology," and on the following day Mr. J. Ramsbottom will read a paper on "The History of the Ustilaginales." The Honorary Secretary is Mr. Carleton Rea, 34, Foiegate Street, Worcester.

MINERAL RESOURCES OF GREAT BRITAIN.—The Board of Agriculture and Fisheries desires to give notice of the publication of a second edition of the first volume of the Special Reports on the Mineral Resources of Great Britain, which have been prepared by the Director of the Geological Survey in response to numerous enquiries that have arisen through the conditions brought about by the War. In the main, it is a reprint of the first edition, wherein the uses, distribution, treatment, and output of tungsten and manganese ores are dealt with, and particulars of the mines (active and inactive) are given. Price, 1/-. Copies may be obtained through any bookseller from Messrs. T. Fisher Unwin, Limited, 1, Adelphi Terrace, London, E.C., who are the sole wholesale agents to the trade outside the county of London; or from the Director-General, Ordnance Survey Office, Southampton.

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